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ABSTRACT

"Eukiefferiella" and "Tvetenia" are closely related genera belonging to the subfamily Orthocladiinae within the Chironomidae, a family of non-biting midges. All known larvae in these genera are aquatic, being found predominantly in running water. Most species prefer cold, swift-flowing, well-oxygenated streams. Although larvae and pupae of these genera are commonly encountered in streams surveys, there is little information on their taxonomy and ecology in the North American literature. This bulletin is an attempt to subdivide these large and ecologically diverse genera into 12 species groups (groups of similar species). For each group, photographs and distinguishing characteristics are provided to allow positive group identification of the larvae. Taxonomic and ecological discussions are also provided for each group. An historical review, key to species groups presented, comments on the format used in the bulletin, a cladogram illustrating possible phylogenetic relationships within the genera based on larval morphological characters, and a discussion of the methodology employed (including collecting/mounting techniques) are included. (JN)

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# LARVAE OF NORTH AMERICAN *EUKIEFFERIELLA* AND *TVETENIA* (DIPTERA: CHIRONOMIDAE)

ROBERT W. BODE

Center for Laboratories and Research
New York State Department of Health
Albany, New York 12201

Bulletin No. 452
New York State Museum

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## ABSTRACT

The larvae of North American *Eukiefferiella* and *Tvetenia* (Diptera: Chironomidae) are classified into 12 species groups (i.e., groups of similar species). Larvae of these two closely related genera commonly are found in running waters and often are reported in biological water-quality surveys. Although there are an estimated 40 North American species in these genera, the fauna is poorly known, with only 3 species formally described to date. The 12 species groups described in the present study are believed to include almost all North American species in these genera.

The species groups are based on Palearctic species and species groups. Most species were reared or associated with pupae and/or adults and were correlated with species described in the European literature. Pupae were found to provide the most satisfactory generic diagnoses and are the most useful stage for separating species and species groups.

For each species group, photographs and distinguishing characters are provided to allow positive group identification of the larvae. The most useful larval characters are abdominal setation, size and shape of the mentum and ventromental plates, antennal characters, and relative size of the procerci and anal parapods. Taxonomic and ecological discussions are provided for each species group. These include pertinent information from the literature in addition to data gathered in the present study. The larvae exhibited marked ecological differences at the group level; some groups were found to be very tolerant of pollutional stresses.

A cladogram based on larval characters is provided to illustrate possible phylogenetic relationships among the species groups. The species group concept is considered to be the best interim measure for identification of the poorly known North American fauna and will provide a framework for future research in these two genera.

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## INTRODUCTION

*Eukiefferiella* and *Tvetenia* are closely related genera belonging to the subfamily Orthocladiinae within the Chironomidae, a family of nonbiting midges. All known larvae in these genera are aquatic, being found predominantly in running water. Most species prefer cold, swift-flowing, well-oxygenated streams; they often live among the moss and algae attached to submerged stones. Although larvae and pupae of *Eukiefferiella* and *Tvetenia* are commonly encountered in stream surveys, there is little information on their taxonomy and ecology in the North American literature. This bulletin is an attempt to subdivide these large and ecologically diverse genera into species groups (i.e., groups of similar species). Within this framework, both the identification of the larvae and ecological information on the groups are presented.

The genus *Eukiefferiella (sensu* Thienemann, 1926) has been reorganized by Saether and Halvorsen (1981) into a restricted *Eukiefferiella*, an amended *Tvetenia*, and the new genus *Dratnalia*. The present paper includes species groups of *Eukiefferiella* and *Tvetenia; Dratnalia* is known only from Europe. Larvae of *Eukiefferiella* and *Tvetenia* may be separated from other Orthocladiinae using the recent key of Cranston (1982).

Most descriptions in this paper are based on specimens collected in New York, but these were supplemented with additional material from other states and provinces, so that most North American species groups of the two genera are included here. Much remains to be learned about the ecology of *Eukiefferiella* and *Tvetenia*, and many species remain to be described in North America. It is the intent of this publication to allow identification beyond the genus level and to provide a framework for further research.

## HISTORICAL REVIEW

Dr. August Thienemann erected the genus *Eukiefferiella* in 1926, naming it in honor of Dr. J. J. Kieffer, who had died the previous year. Thienemann credited Kieffer with laying much of the groundwork for European chironomid systematics. Thienemann's concept of the genus (1926, p. 325) was based on pupal characteristics. He designated as the type species the organism hitherto known as *Dactylocladius longicalcar* Kieffer 1911, separating it from other species of *Dactylocladius* on the basis of its pupal prothoracic horns with bulbous, swollen bases and long filamentous tips. He also moved *Dactylocladius brevicalcar* Kieffer to the new genus. Thienemann did not include the adults of *Eukiefferiella*, stating that he would leave adult characters to adult systematics.

Edwards (1929), of the British Museum, first attempted to define adult characters for the genus. He found, however, that the single specimen of *E. longicalcar* sent to him by Thienemann did not correspond with Kieffer's original description. In its stead Edwards described specimens of *E. brevicalcar* Kieffer and designated this as the new type species for the genus. Edwards enlarged the genus by describing four new species and incorporating three existing species of *Dactylocladius*, including the North American *D. brevinervis* Malloch. Finally, he made *Eukiefferiella* a subgenus of *Spaniotoma*, based on adult characteristics.

Thienemann (1936a) did not agree with Edwards's concept of *Eukiefferiella* and asserted that three of the species Edwards placed in the genus should not be included: *E. bicolor*, *E. coronata*, and *E. coerulescens*. (*E. bicolor* is now recognized as belonging to *Nanocladius* and *E. coronata* to *Parakiefferiella*, while *E. coerulescens* properly belongs to *Eukiefferiella*.) Thienemann addressed the type species problem which Edwards had raised and suggested that *E. longicalcar*, as described by Potthast (1914) be the type species. Thienemann's paper also contained descriptions of new species, raising the number within the genus to 14. Most of these new species were actually authored by Dr. M. Goetghebuer, who has made many other significant contributions (Goetghebuer, 1934, 1935, 1940–50). Thienemann included determination keys for larvae and pupae and recognized three groups of similar species. Thienemann noted in this paper: "Die Formenmannigfaltigkeit der Gattung *Eukiefferiella* ist allerdings auch mit der folgenden Darstellung noch bei weitem nicht erschöpft!" (The diversity of form of the genus *Eukiefferiella* is, of course, far from being exhausted even in the following presentation!)

Zavřel (1939) advanced the knowledge of the genus further with keys and descriptions of larvae and pupae of 18 European species. Working with material from Thienemann and Edwards in addition to his own, Zavřel found larval and pupal characters shared by all the species and recognized the validity of *Eukiefferiella* as a uniform, independent genus. He used seven species groups and included *E. coerulescens*, which Thienemann earlier had transferred to *Akiefferiella*. Forty years later Zavřel's modest 28-page work stands as the most complete study of *Eukiefferiella* larvae. His generic characters and many of his species groups are still recognized as valid.

Meanwhile Dr. O. A. Johannsen, of Cornell University, was laying the groundwork for systematics of the aquatic Diptera of North America. Johannsen (1937) agreed with Edwards (1929) in making *Eukiefferiella* a subgenus of *Spaniotoma*. In addition Johannsen subdivided *Eukiefferiella* into the three "groups" used by Thienemann (1936b): *Eukiefferiella*, *Akiefferiella*, and *Parakiefferiella*. He also briefly described the larvae and pupae of the European species *E. discoloripes* and *E. longicalcar*, and placed in the *Akiefferiella* group a species he had originally described (1905) as *Orthocladius sordens*. Sublette (1967) later declared *O. sordens* to be a *nomen dubium*, due to the poor condition of the type specimens; moreover the larva of this species was only questionably associated with the adult.

Chernovskii (1949) keyed larvae of 17 Palearctic species of *Eukiefferiella*, including 3 new Russian species. This detailed key differentiated larvae mostly on the basis of antennal ratios, teeth of the mentum, and body setation.

Johannsen (1952), dealing with adults in a guide to the insects of Connecticut, closely followed Edward's (1929) adult characters. *Eukiefferiella* was placed as a subgenus of *Hydrobaenus*, a genus name which was cited as taking precedence over *Spaniotoma*.

Roback (1957) returned *Eukiefferiella* to full generic status and raised Johannsen's (1937) groups to subgenera of *Eukiefferiella*. Of this decision he said, "The writer considers the adult wing character of greater importance than those of the immatures and agrees with Goetghebuer in considering these as subgenera of *Eukiefferiella* s. str." Roback included 10 species in his larval and pupal keys, but five of these were European, one was a *Parakiefferiella*, and two were unnamed species. The two North American species were *E. brevinervis* and *E. sordens*, of which only the former is valid.

Brundin (1956) worked on the adults of *Eukiefferiella* and was able to provide the first satisfactory adult diagnosis. He used five species groups and discussed the phylogenetic position of *Eukiefferiella* within the subfamily Orthocladiinae. He also addressed the problem of the proper type species for the genus. After studying the type material, he declared *E. longicalcar* Kieffer 1911 a *nomen nudum* and replaced it with *E. longicalcar* Potthast 1914, as the proper type species.

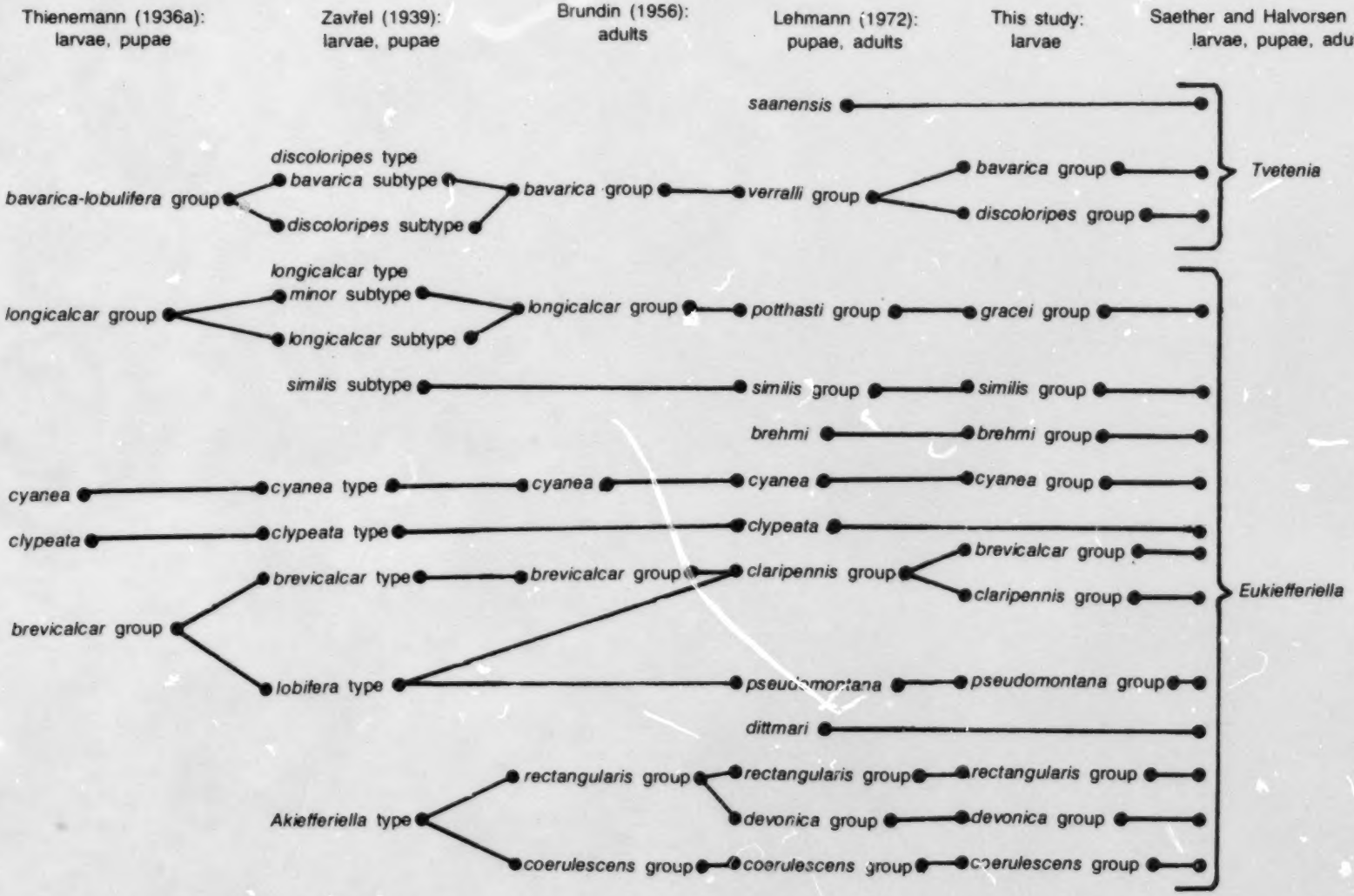
In the catalog of North American Diptera Sublette and Sublette (1965) placed species of *Eukiefferiella* under the genus *Nanocladius*. However, *Nanocladius* and *Eukiefferiella* are now recognized as distinct genera, due in part to recent revisions of *Nanocladius* by Saether (1977a) and of *Eukiefferiella* by Lehmann (1972).

Lehmann's (1972) revision of *Eukiefferiella* included pupae and adults of 26 European species. It synthesized almost all previous work on the genus and included taxonomic keys, numerous illustrations, and a discussion of phylogenetic relationships within the genus. The species descriptions were abbreviated, presenting the salient characters needed to distinguish the species. Lehmann recognized six species groups, based on pupal and adult characters. Much of his scheme has been followed in this bulletin.

Sublette (1970) redescribed the adult male of *E. brevinervis* (Malloch) and noted: "This is the only species recorded for this genus from North America." At about the same time Saether (1969) described two new species of *Eukiefferiella* from Canada, bringing the total number of described Nearctic species for the genus to three.

Recently Saether and Halvorsen (1981) found *Tvetenia* Kieffer 1922 to be a senior synonym of *Eukiefferiella*, since the species *T. duodenaria* was shown to be a senior synonym of *E. saanensis*. Consequently *E. saanensis* was synonymized, and its allies, the *discoloripes* group and the *bavarica* group, were transferred to *Tvetenia*. Another species, *E. szczensnyi* Dratnal (1979), was shown to be a junior synonym of *Stenocladius potamophylaxi* and was transferred to the new genus *Dratnalia*. All other known species remained in the genus *Eukiefferiella*.

**Table 1. Groupings of *Eukiefferiella* and *Tvetenia* by various authors.**



## USE OF SPECIES GROUPS

No identification to species level of any North American larva of *Eukiefferiella* can as yet be considered valid without an associated adult. Even with associated adults, assigning Palearctic species names to Nearctic specimens is often risky without examining type specimens. This will be part of the task involved in revising the genus for the Nearctic fauna. For the present we are left with carrying taxa through the European keys as far as we safely can. This usually leaves us at the level of species groups, which are being advocated here as the best interim measure for working on *Eukiefferiella* in North America.

Species groups as used here refer to assemblages of closely related taxa within a genus. Mayr (1969) has stated that they may be employed as terms of convenience, without reference to formal taxonomic hierarchy. Species groups in *Eukiefferiella* were first used by Thienemann (1936a) and have remained in use since then as a convenient way of organizing the genus. Each author has modified the group structures somewhat by splitting, lumping, or rearranging groups, usually dependent on whether he was working on larvae, pupae, or adults (Table 1). The groups used in the present study are based on both larval and pupal characteristics, and the classification tends toward splitting groups, based on larval differences. Zavřel's (1939) practice of making every species assignable to a group is followed here.

For purposes of identification, species groups are the most satisfactory alternative when species names cannot be determined. A common practice among North American biologists has been to assign numbers to unknown species in a genus; but since there is no commonly accepted system these numbers are usually meaningless to other biologists. Another common practice has been to designate the closest European species; e.g. *Eukiefferiella* cf. *brevicalcar*. While this method is acceptable and can sometimes relay more exact information than placement in a species group, it should not replace the use of species groups. The understanding and use of species group limits will lay a firmer groundwork for taxonomic advancement in this genus in North America.

One important result of placing a taxon in the proper species group is to reveal its phylogenetic relationships within the genus. Insights into its probable life history and general ecological requirements can then be gained. These vary among the groups but are quite consistent within each group. Isolated descriptions of new Nearctic species should also adhere to the group concept and address the new species' relationship to other taxa in the group.

With respect to future taxonomic work on Nearctic *Eukiefferiella*, the species group approach will also lend itself useful by subdividing the genus. Revising the Nearctic fauna will involve an examination of the European type specimens, as well as descriptions of several new species. Attempting to revise the entire genus is therefore so formidable a challenge that it may not be undertaken in the near future. Subdividing the challenge at the group level seems to be a reasonable and orderly interim approach.

For purposes of identification, for phylogenetic and ecological understanding, and for an orderly approach to future taxonomic work, the species group concept seems the best course to follow for Nearctic *Eukiefferiella*.

## METHODS

### Collection and mounting techniques

Most specimens were collected from flowing waters within New York State, many during biomonitoring surveys, by standardized sampling techniques. Sites were sampled quantitatively with modified Hester-Dendy multiple-plate samplers (Hester and Dendy, 1965). Each sampler consisted of three plates of 6-inch-square pressed hardboard, mounted on an aluminum turnbuckle; the plates were separated with ⅛-inch and ⅜-inch spacers. The sampler was suspended 3

feet beneath the water surface from a Styrofoam-filled float or was suspended from a navigation buoy when one was available. After a 5-week exposure period the sampler was retrieved and disassembled, and the macroinvertebrates were scraped off the plates. The sample was retained with a No. 30 sieve and preserved in 70% ethyl alcohol containing a Rose Bengal stain, added to aid in sorting (Mason and Yevich, 1967).

Since multiple-plate samplers sample only a segment of the benthos, the sites were also sampled qualitatitively. The methods differed with the physical characteristics of the river or stream. Large rivers were sampled with a Ponar grab or Ekman dredge sampler; shallower streams were usually sampled with a D-frame net or Surber sampler (Merritt and Cummins, 1978).

During the study, the methods gradually evolved to sample more specifically for *Eukiefferiella* larvae and pupae. The most satisfactory method was to examine individual rocks, where larvae and pupae were often found among the attached moss and algae. Drifting pupal exuviae were collected with Surber samplers, which were left in place for about an hour. Pupal exuviae were also collected with a sieve from the water surface, usually in areas of slack current near the stream edge.

In the laboratory larvae and pupae were picked from the samples and sorted into recognizable groups. They were then cleared in a warm solution of 10% potassium hydroxide, rinsed successively in distilled water and 95% ethyl alcohol, and mounted in Diaphane or Euparal on glass slides. Larval and pupal exuviae were rinsed in 95% ethyl alcohol, then mounted in Diaphane or Euparal.

### Association techniques

The strategy of this study was to associate the larval and pupal stages. Pupal characteristics historically have been most useful for defining the species groups (Thienemann, 1936a; Lehmann, 1972) and were the main criteria for establishing species group limits in this study. The basic association method was the fundamental rearing technique as described by Roback (1976). In this method a larva is placed in a vial of water (preferably distilled water), which is sealed with a styrofoam plug and maintained at a proper temperature (15–20°C). After the adult emerges, it is knocked down with a stream of alcohol, and the larval and pupal skins are retrieved from the vial.

This method resulted in few adult emergences for species of *Eukiefferiella* and *Tvetenia*, presumably because of their rheophilic nature. Other rearing methods were attempted which provided a current (Mason and Lewis, 1970), but many species still could not be reared successfully, usually dying as pupae. Zavřel (1939) similarly reported that, for *Eukiefferiella*, he could rear many larvae to pupae but few through to adults.

Other association techniques included examining mature larvae (prepupae) to see pupal structures and examining mature pupae to see adult structures. With this method a complete larva-pupa-adult association sometimes may be made without rearing.

### Terminology and morphological methods

Diagnostic characters are shown in Figures 1 and 2. The terminology used follows that presented in Saether's (1980) glossary. Measurement techniques were similar to those described by Soponis (1977). All measurements were made with a Bausch and Lomb compound microscope with an ocular grid at a magnification of 430X, except that body length was measured at 100X. For some structures, such as labral setation or antennal details, it was desirable to use a Zeiss compound microscope with a phase-contrast objective.

## GENERIC DIAGNOSES FOR LARVAE

Saether and Halvorsen (1981) have redefined *Tvetenia* and *Eukiefferiella* and provided generic diagnoses for adults, pupae, and larvae. These diagnoses probably are based primarily on Palearctic species and no doubt omit some of the Nearctic species which provide exceptions to the generic limits. Based on the results of the present study, the larval diagnoses should be altered slightly. The revised diagnoses for the larvae are summarized in Table 2.

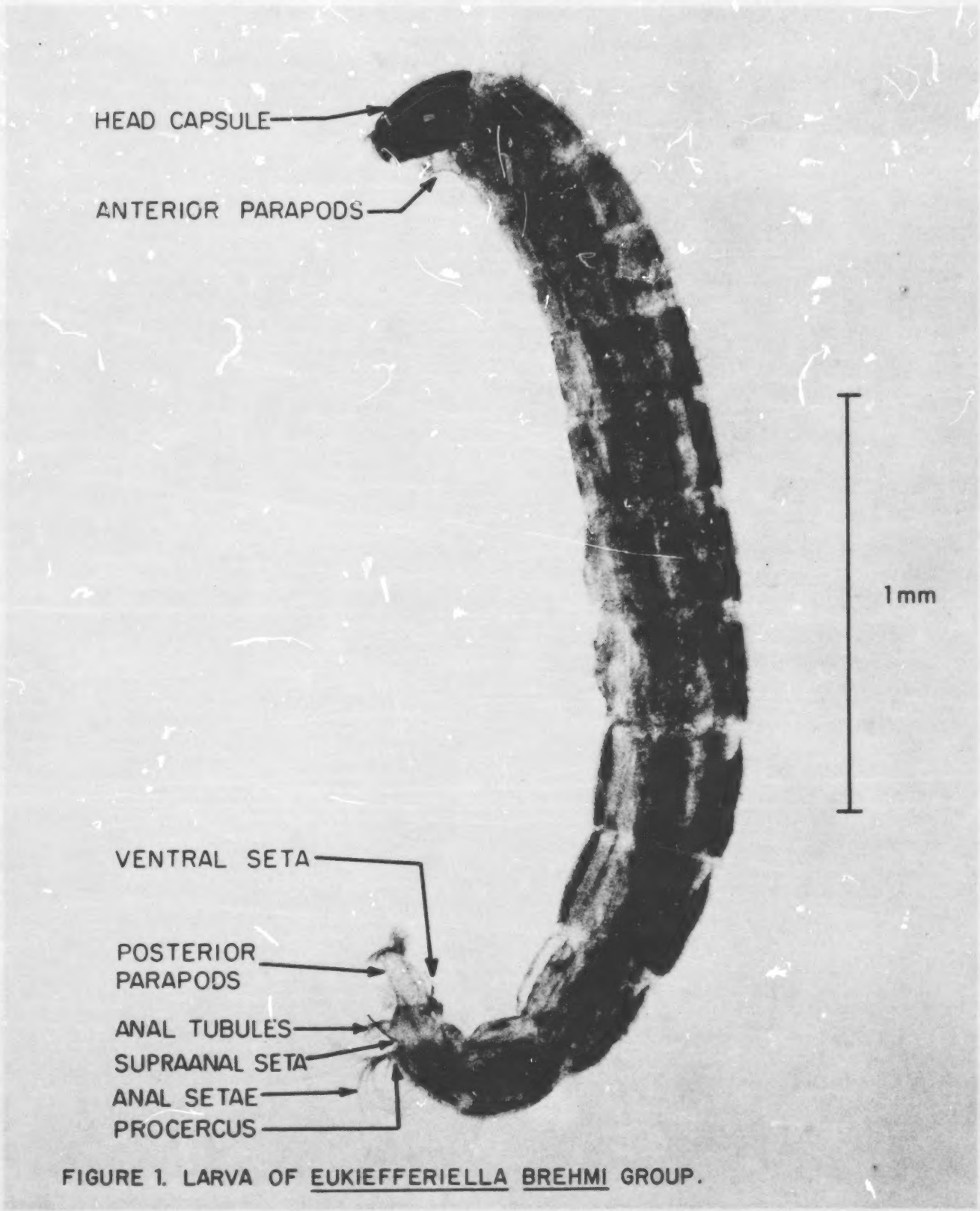



FIGURE 1. LARVA OF EUKIEFFERIELLA BREHMI GROUP.

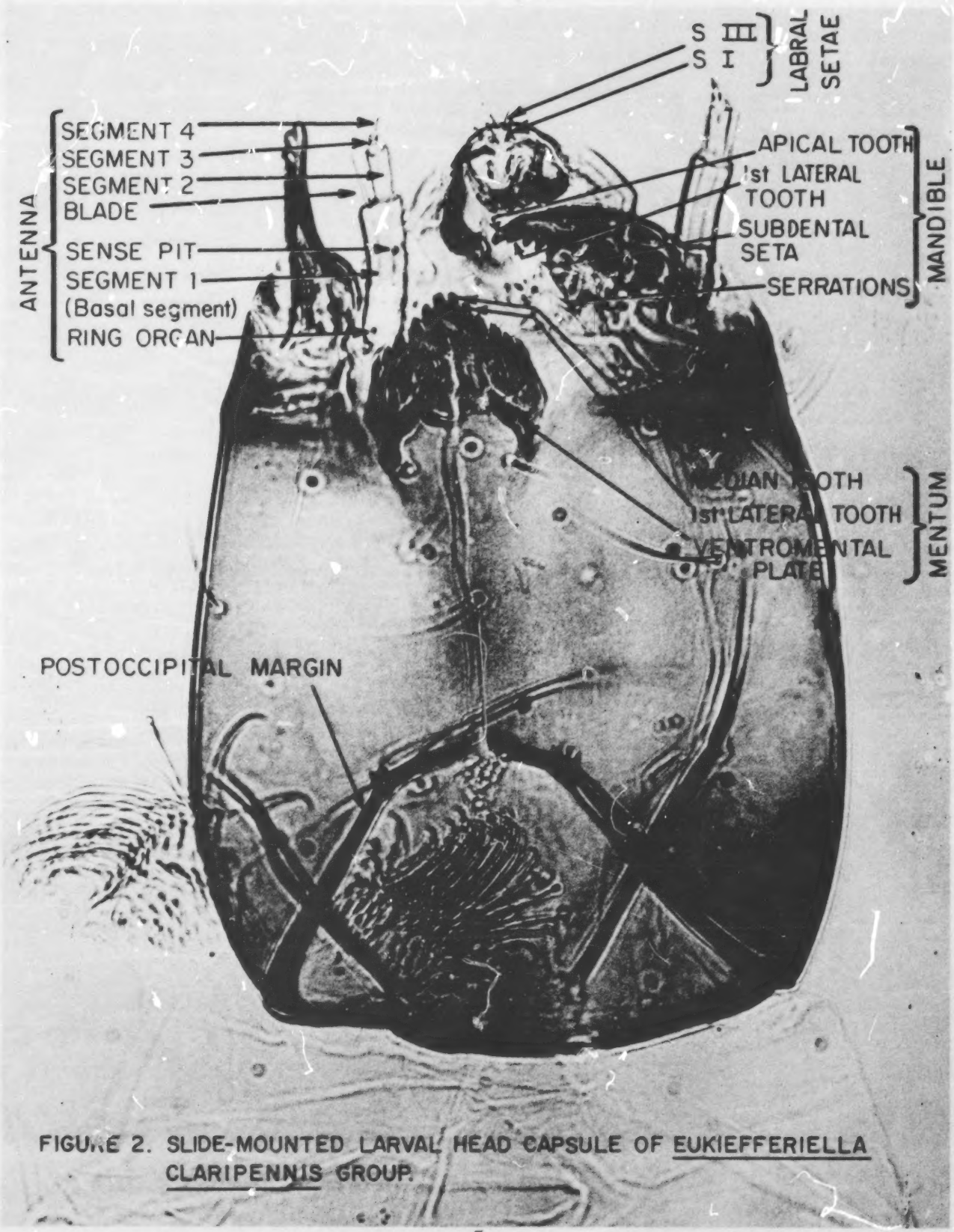



FIGURE 2. SLIDE-MOUNTED LARVAL HEAD CAPSULE OF EUKIEFFERIELLA CLARIPENNIS GROUP.

For *Tvetenia* Saether and Halvorsen state that the 4th antennal segment is longer than the 3rd, but in all my *discoloripes* group specimens the reverse is true. These specimens also display long mandibular serrations, which Saether and Halvorsen say are always short. Finally the ventromental plates are not always "very narrow," as stated in the diagnosis, but in some species are widened and triangular.

For *Eukiefferiella* the ventromental plates are also stated to be very narrow and inconspicuous; but a notable exception is seen in the *pseudomontana* group, which has relatively large, triangular ventromental plates. The serrations on the inner margin of the mandible, which are stated to be usually long, are very short in four of the species groups. Finally, the *cyanea* group larvae offer exceptions to a well-developed procercus and have only 4, not 5–7, anal setae.

## Table 2. Diagnosis table for mature larvae.

| | *Tvetenia* | *Eukiefferiella* |
|---|---|---|
| Body length | 2.5–7.5 mm | 1.5–6.0 mm |
| Body pigmentation | Flesh-colored, green-brown blue-violet | Green-brown to blue-violet |
| Head capsule pigmentation | Yellow to pale brown | Pale brown to dark brown |
| Body setation | Abdomen with setae half as long as segment | Abdomen with no setae half as long as segment |
| Antennal segments | 5 | 4 or 5 |
| Antennal ratio | 1.40–2.20 | 1.10–2.35 |
| Antennal blade | Longer than segment 2 | Equal to or longer than segment 2 |
| Antennal segment 3 | Longer than, shorter than or subequal to segment 4 | Shorter than or subequal to segment 4 |
| Mandible inner margin | Sometimes smooth, usually with 2–3 serrations | With 1–4 long or short serrations |
| Premandible | Simple | Simple |
| Mentum, median tooth | Single or paired | Single or paired |
| Mentum, lateral teeth | 5 pairs | 4 or 5 pairs |
| Ventromental plates | Triangular or rounded basally | Triangular, rounded basally, or indistinct |
| Labral seta I | Divided | Simple |
| Labral setae II and IV | Simple | Simple |
| Labral seta III | Simple | Simple or bifid |
| Posterior parapods | Length/width 2.0–4.0 | Length/width 1.5–6.0 |
| Procercus | Length/width $>$ 1.5 | Length/width $<$ 1.5 |
| Procercus basal seta | Long | Usually long, sometimes reduced |
| Anal setae | 5–8 setae, longer than posterior parapods | 4–7 setae, usually longer than posterior parapods, or reduced |
| Supraanal seta | Long, about as long as posterior parapods | Sometimes greatly reduced, sometimes long |
| Anal tubules | Shorter than posterior parapods | Shorter than posterior parapods |

## KEY TO SPECIES GROUPS INCLUDED

1. Head capsule yellow to light brown; procerci 1.5–2.0 times longer than wide; middle abdomen (excluding thorax and last 2 abdominal segments) with some setae at least 1/2 as long as corresponding segment; labral seta I divided into two or more branches ....*Tvetenia* ....2
   Head capsule medium brown to black; procerci less than 1.5 times as long as wide; middle abdominal setae less than 1/2 as long as corresponding segment; labral seta I simple .....
   .....*Eukiefferiella* ....3
2. Mentum with single median tooth; ventromental plates pointed at lateral margins .....
   .....*discoloripes* group (p. 12)
   Mentum with two median teeth; ventromental plates rounded at lateral margins .....
   .....*bavarica* group (p. 14)
3. Middle abdominal setae at least 1/10 as long as segment; antennal blade longer than antennal segment 2, usually reaching apex of segment 4 .....4
   Middle abdominal setae less than 1/10 as long as segment; antennal blade about as long as antennal segment 2 .....7
4. Mentum with 4 pairs of lateral teeth; labral seta III bifid, head capsule height (unmounted) about 3/4 of head length .....*devonica* group (p. 16)
   Mentum with 5 pairs of lateral teeth, labral seta III simple; head capsule height (unmounted) only about 1/2 of head length.....5
5. Antennal ratio 1.00–1.20, 3rd segment no longer than wide; anal setae reduced, shorter than posterior parapods; middle abdominal setae only 1/5–1/6 as long as corresponding segment; mentum with single pointed median tooth .....*similis* group (p. 18)
   Antennal ratio 1.20–1.80, 3rd segment longer than wide; anal setae longer than posterior parapods; middle abdominal setae at least 1/3 as long as corresponding segment; mentum variable .....6
6. Mentum with single median tooth; antennal ratio 1.50–1.80.....*gracei* group (p. 22)
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8. Sense pit located at midpoint or proximal to midpoint of basal antennal segment .....9
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9. Antenna 5-segmented, blade slightly longer than segment 2; mentum with median teeth quadrate and well-separated; ventromental plates rounded at posterolateral corner .....
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## COMMENTS ON THE FORMAT USED

The format of this bulletin varies in several respects from a conventional taxonomic presentation. First, the emphasis has been placed on photographs, rather than drawings. While photographs generally are not as effective in showing details (although these have been drawn in for some structures), they are often more effective in showing the whole appearance, including subtleties that might not be included in a drawing yet are important for recognition. Second, the placement of each description directly adjacent to the photograph or drawing is an attempt to make these pages more usable, to eliminate paging from description to illustration for every character. Third, the structures illustrated on any given page often are a collection from more than one specimen. These structures represent the range for a group of species and were chosen from many specimens to be the most representative, as well as the most clearly photographable. It is hoped that this format will facilitate correct identification to species group and allow direct comparisons between the groups.

# THE SPECIES GROUPS, WITH TAXONOMIC AND ECOLOGICAL NOTES



cl 19

## TAXONOMY

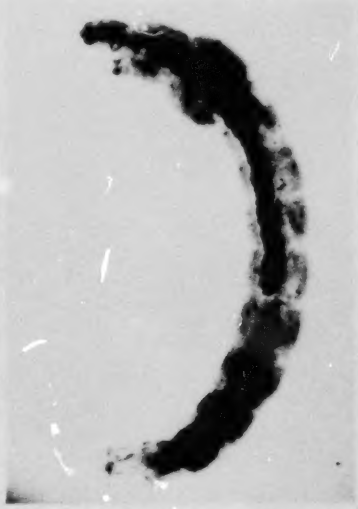
The *discoloripes* group was transferred from *Eukiefferiella* to *Tvetenia* by Saether and Halvorsen (1981), based on characters of all stages. Larvae of *Tvetenia* are distinguished by more pronounced body setation (at least half as long as corresponding body segment), longer procerci (at least 1.5 times longer than wide), a divided labral seta I, and a lighter-colored head. Thienemann (1936a) and Zavřel (1939) separated the *discoloripes* group and the *bavarica* group as subtypes on the basis of larvae, but Lehmann (1972) included them both in the *verralli* group.

I have separated the *discoloripes* group from the *bavarica* group as larvae on the basis of the single median tooth of the mentum and the posterolaterally pointed ventromental plates. Although I have examined a large number of *discoloripes* group specimens and observed considerable variation in the larvae, I have not been able to find any characters to separate species satisfactorily.

The North American larvae differ from Goetghebuer's description of *E. discoloripes* (in Thienemann, 1936a) in that Goetghebuer described the mandible as lacking serrations on the inner margin. Our species more closely resemble *E. tshernovskii*, illustrated by Pankratova (1977), showing a mandible with long serrations on the inner margin. Roback's (1957) "*Eukiefferiella* sp. 1" belongs here; "*Eukiefferiella* sp. 1" pictured in Oliver et al. (1978) shows the typical *discoloripes* group mentum but lists a simple SI, so this is possibly not *Tvetenia*.

## ECOLOGY

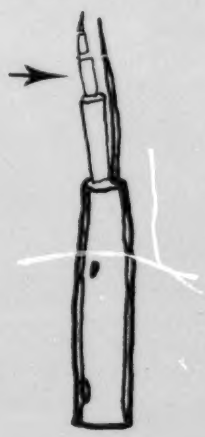
Larvae from this group are widely distributed and common in North America, being reported from the Northwest Territories and Yukon Territory (Oliver et al., 1978), Colorado (Saether, 1970), Pennsylvania (Roback, 1957; Coffman, 1973), Florida (Beck, W.M., pers. comm.), and New York (Simpson and Bode, 1980). I have also examined specimens from Wisconsin, Minnesota, Michigan, and North Carolina. The larvae are found in such a variety of habitats that more than one species are likely to be involved. Elgmork and Saether (1970) reported larvae (as *Eukiefferiella* sp. A) from a high mountain tributary in Colorado at an elevation of 3,400 meters with the water temperature a fairly uniform 10°C. In New York larvae are more commonly found in larger, warmer rivers, where summer water temperatures may reach 25°C. They may also be found in organically enriched sections where dissolved oxygen concentrations drop below 5.0 ppm, but they seem to require a current speed of at least 15 cm/s. I have observed the emergence period to be April through October, and this has been similarly reported by Lehmann (1971) and Coffman (1973). Wartinbee (1979) observed the emergence to be continuous throughout the day, with no obvious diel pattern. Coffman (1971) has reported the larvae to be herbivores, ingesting 60% algae and 40% detritus. I have most often found larvae in association with the alga *Cladophora*; Thienemann (1954) listed *E. discoloripes* as part of the moss fauna.



Body length of mature larvae 3.5–5.8 mm; body from pale flesh-colored to blue-violet; middle abdominal setation prominent, seta/segment ratio 0.50–0.70.

Posterior parapods of medium length, length/width ratio about 3; procerci long, length/width ratio about 1.5; supraanal seta almost as long as parapods; anal tubules half as long as parapods.

Head straw-colored to light brown; postoccipital margin laterally light between 2 sclerotized lines.



Antennal ratio 1.50–1.90; antennal blade as long as segments 2–4; 3rd segment longer than 4th segment.

Inner margin of mandible with 2–3 long serrations reaching base of subdental seta (absent in European species); apical tooth longer than 1st lateral tooth.

Mentum with 5 lateral teeth; median tooth single, with a median point; ventromental plates prominent, pointed at posterior end.

## TAXONOMY

Thienemann (1936a) originally created the *bavarica-lobulifera* group to include *E. bavarica*, *E. lobulifera (calvescens)*, and *E. discoloripes*. Zavřel (1939) treated the *bavarica* group and the *discoloripes* group as subtypes under the *discoloripes* type. Lehmann (1972) combined these in the *verralli* group. Identification of larvae of *E. verralli* and *E. calvescens* was recently discussed by Fahy (1972); in addition to quantitative differences the larvae could be distinguished by the postoccipital margin, which was dark in *E. verralli* and light in *E. calvescens*.

Saether and Halvorsen (1981) transferred members of this group from *Eukiefferiella* to *Tvetenia*. The *bavarica* group as used here differs from the *discoloripes* group as larvae in having paired median teeth on the mentum, rounded ventromental plates, and smaller serrations on the mandible. These characters, along with well-developed procerci and strong body setation make the *bavarica* group quite easily recognizable. Saether (1969) has described two species from Canada which he recognized as belonging to the *bavarica* group, *E. paucunca* and *E. vitracies*. The larval and pupal material I have examined indicate that there are several more North American species in this group, which remain to be described.

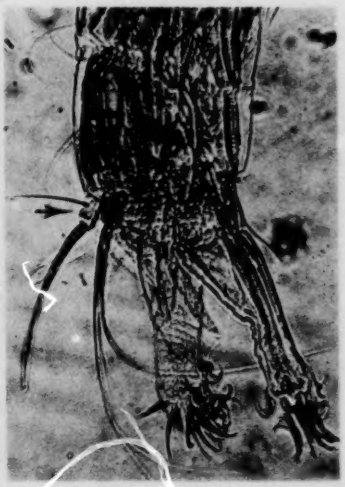
## ECOLOGY

Members of this group are widespread in North America and probably are the most commonly collected of any *Tvetenia* or *Eukiefferiella*. They have been reported from Alaska (Tilley, 1979), Alberta, Manitoba, and Ontario (Saether, 1969), Northwest Territories and Yukon Territory (Oliver et al., 1978), Colorado (Saether, 1970), New York (Simpson and Bode, 1980), and Pennsylvania (Roback, 1957). In addition I have examined specimens from Idaho, Wisconsin, Minnesota, Michigan, North Carolina, South Carolina, and Alabama. The range of habitat types extends from glacier brooks in the Rocky Mountains (Elgmork and Saether, 1970) to coastal plain streams in North Carolina (Lenat, D.R., pers. comm.), and since there are many species of varied habitats, it is difficult to characterize the group as a whole.

The species I have collected in New York occasionally are found in medium-sized rivers with summer temperatures up to 20°C, but most are collected in small streams and tributaries and prefer strong currents. One species in North Carolina is very tolerant to low pH and agricultural runoff and is sometimes the dominant chironomid in such situations (Lenat, D.R., pers. comm.).

My collections of *bavarica* group larvae have been from either moss or bare stones, and the literature generally agrees with this. Larvae of *E. verralli* have been reported to be numerous in *Helodea* vegetation in a Danish lowland stream, living in loosely constructed tubes and feeding on detritus which collected in the vegetation (Lindegard-Petersen, 1972). Although these larvae were rheobiontic, they were not found in the strongest currents, where detritus would not accumulate. Loosely constructed cases have been recorded for other species in this group by Zavřel (1939) and Brennan and McLachlan (1980).

Body length of mature larvae 2.5–7.5 mm; body flesh-colored to green-brown; middle abdominal setation prominent, seta/segment ratio 0.40–0.70.



Posterior parapods 2–3 times as long as wide; procerci 1.5–2.0 times as long as wide; supraanal seta almost twice as long as ventral seta of same segment.

Head straw-colored to light brown; postoccipital margin either light or dark.

Antennal ratio 1.40–2.20; 3rd segment sometimes shorter than 4th segment; blade at least as long as segments 2–4.

Inner margin of mandible with 2–3 medium sized serrations, not reaching base of subdental seta; apical tooth longer than 1st lateral tooth.

Mentum with 5 pairs of lateral teeth; median teeth paired and pointed, partially fused; ventromental plates with posterior end rounded.

## TAXONOMY

To my knowledge there are no records in the literature of the occurrence of *Eukiefferiella devonica* group in North America. Larval identification of the group has not been possible with North American keys to date. The larvae are quite unlike other *Eukiefferiella* and often are mistakenly placed in other genera.

Several features make larvae of the *devonica* group unique among *Eukiefferiella*. The head is stout, not of the typical *Eukiefferiella* shape, the mentum has only 4 pairs of lateral teeth, and labral seta III is bifid. Although the pupae and adults of this group show many apomorphic characters, as pointed out by Lehmann (1972), the larvae display many plesiomorphic features, including low antennal ratios, long serrations on the inner margin of the mandible, and well-developed abdominal setation (see PHYLOGENETIC RELATIONSHIPS).

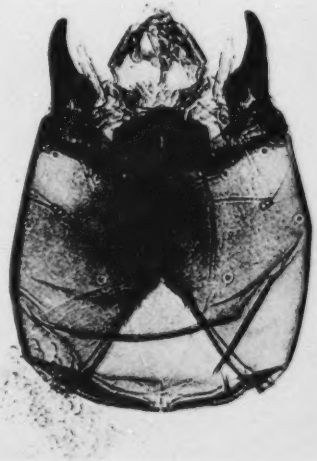
The group is based on two similar European species, *E. devonica* and *E. ilkleyensis*, described as adults by Edwards (1929); the species names are derived from two localities in England, Devon County and the town of Ilkley. Zavřel (1939) was not able to associate larvae for the *devonica* group, though it is now fairly certain that his unassociated larva "cfr. *similis* juv. 1" belongs here. It is interesting that he placed it in the *longicalcar* group (presently *gracei* group). Zavřel was able to associate the pupa of *E. devonica* and placed it with *E. coerulescens* in the genus *Akiefferiella*. This usage was retained until Brundin (1956) returned these to *Eukieferiella*. Goetghebuer et al. (1949) and Ertlová (1971) described the larva and pupa of *E. lutethorax*, which Lehmann (1972) later synonymized with *E. ilkleyensis*.

## ECOLOGY

The group is apparently widely distributed in North America, though it is less commonly collected. I have examined specimens from Manitoba, Idaho, Colorado, Minnesota, Michigan, New York, North Carolina, and South Carolina. Members of this group from New York are associated with moss and algae in unpolluted, swift-flowing, small streams; occasionally they are found in rivers with maximum temperatures of 20°C. *E. devonica* and *E. ilkleyensis* have been recorded from a variety of habitats in Europe; in moss and algae of swift-flowing sections of the River Dodder in Ireland (Goetghebuer et al., 1949), in the moss of high mountain brooks of the Alps (Thienemann, 1954), from the lower section (altitude 1,850–1,950 m) of a high mountain torrential stream in the Pyrenees (Laville and Lavandier, 1977), and from gravel and the macrophyte *Ranunculus* in an English chalk stream (Pinder, 1980). Adults of *E. devonica* have been collected at a lake in Norway (Thienemann, 1941, as reported in Saether, 1968) and at a Spanish reservoir (Prat, 1977), so it is possible that the larvae also occupy the littoral zone of lakes. My records indicate a probable summer emergence.

Body length of mature larvae 1.5–3.9 mm; body blue-green to green-brown; middle abdominal setation quite prominent, seta/segment ratio 0.30–0.50.

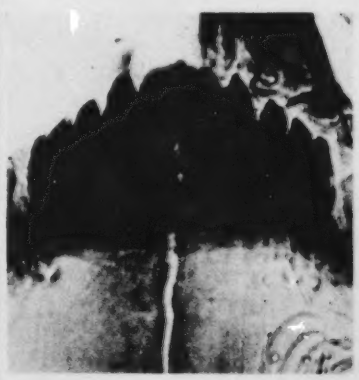
Posterior parapods short, less than twice as long as wide; procerci as long as wide; anal tubules almost as long as parapods; supraanal setae reduced.



Head medium brown to dark brown; postoccipital margin dark, wide; from side view, height of head about ¾ of length; Labral seta III bifid.

Antennal ratio 1.10–1.50; segment 3 shorter than or equal to segment 4; antennal blade at least as long as segments 2–4.

Inner margin of mandible with 3 long serrations, extending beyond base of subdental seta; apical tooth larger than 1st lateral tooth.



Mentum with only 4 pairs of lateral teeth; median tooth single, wide, and peaked, though sometimes worn down; ventromental plates barely discernible.

## TAXONOMY

The single undescribed North American species dealt with here is placed provisionally in the *similis* group. The larva and pupa will key out near *E. similis* in the keys of Zavřel (1939), Chernovskii (1949), and Lehmann (1972), but there are significant morphological differences in both stages. The adult shows even greater differences from *E. similis*, exhibiting characters which could justify its placement in *Cardiocladius* (Coffman, W. P., pers. comm.). In order to describe this as a species of *Eukiefferiella*, which seems most appropriate, generic limits will have to be expanded for both pupae and adults. Additionally this species probably is unique enough to merit its own group status.

The larva can be confused with the *Tvetenia discoloripes* group, because it has a similar mentum. In Roback's (1957) key "*Eukiefferiella* sp. 1" and *E. similis* key out together, although the description of the sp. 1 larva places it in the *Tvetenia discoloripes* group. The larvae of the *similis* group may be separated from the *discoloripes* group by the reduced abdominal setation, poorly developed procerci (not longer than wide), and the lower antennal ratios.

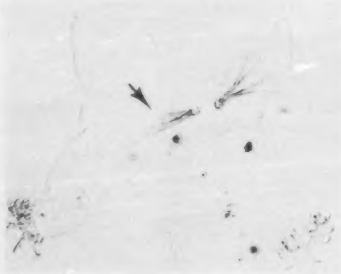
## ECOLOGY

The larvae of this species are encountered infrequently, although the distinct pupal exuviae often show up in drift samples. I have examined specimens from the Muskegon River in Michigan and from the Cohocton River, Neversink River, and Schoharie Creek in New York. These small to medium-sized streams are mostly free from pollution. Currents range from 0.5 to 1.5 m/s, and maximum summer temperatures are 20°C. Pupae and prepupae were collected in June, July, and August. To my knowledge all larvae were collected from algae.

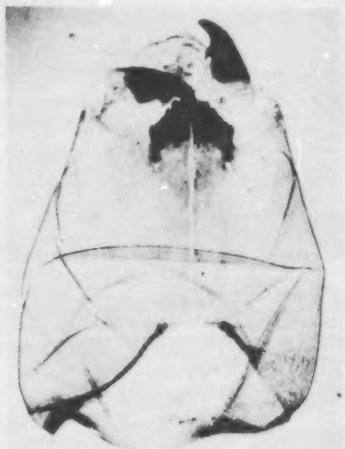
Larvae of this species have also been reported to be ectoparasites of filter-feeding caddisflies, entering pupal cases and apparently causing the death of the pupa by feeding on it (Voshell, J. R., pers. comm.). The larvae are not believed to be obligate parasites. Individuals which do feed on caddisflies can increase greatly in body size, attaining the largest size of any *Eukiefferiella* and accounting for great size variation within the species.

Thienemann (1954) reported the habitat of the European *E. similis* to be the moss of Ubergangsbäche, or transition brooks. These are clear water brooks, usually springfed and often in forested regions. The current may be as strong as 1.8 m/s, and maximum summer temperatures are 9.5°C. In the moss fauna of such brooks Thienemann reported 13 species of *Eukiefferiella* (including *Tvetenia*).

Body length of mature larvae 4.2–6.0 mm; middle abdominal setation reduced, seta/segment ratio 0.15–0.20; body green.



Procerci and anal setae reduced, anal setae shorter than parapods; supraanal and ventral setae reduced; parapods only twice as long as wide.



Head medium brown to dark brown; postoccipital margin narrow and dark; head small in relation to body size.

Basal antennal segment reduced, antennal ratio 1.00–1.20; 3rd segment greatly reduced; blade longer than segments 2–4.

Inner margin of mandible with 1 long serration, almost reaching base of subdental seta; lateral teeth of mandible reduced.

Mentum with 5 pairs of lateral teeth; median single and with a distinct point, though sometimes worn off; ventromental plates triangular but difficult to discern; 5th lateral teeth enlarged.

## TAXONOMY

This group is based on the single European species *E. brehmi*, which Gowin (1943) described from the Austrian Alps. In North America there appear to be 3 undescribed species which will end up in this group. Lehmann (1972) gave brief descriptions of the adult and pupa of *E. brehmi* and listed the larva as unknown. I obtained a larval-pupal association from a specimen loaned by David Lenat and since then have collected more larvae, pupae, and prepupae. Pupal characters agree with the description in Lehmann (1972).

Larvae of the *brehmi* group are distinguished by a very dark head, strong abdominal setation, and a characteristic mentum. The group is closely related to the *gracei* group, and the larvae may be confused with these, especially if the median teeth of the mentum are worn down so as to appear to be a single tooth. However, the smaller body size and lower antennal ratio should be sufficient to distinguish the *brehmi* group.

## ECOLOGY

At least some members of this group appear to be widespread and common in North America. Coffman (1979) listed pupae of three North American species designated "cf. *brehmi*," two of these Western and common, one widespread and common. I have examined specimens from Colorado, Michigan, New York, North Carolina and South Carolina. In New York I have collected larvae from low mountain streams (elevation 500 m) in the Adirondack Mountains, as well as clean, lowland rivers with summer temperatures of 20°C.

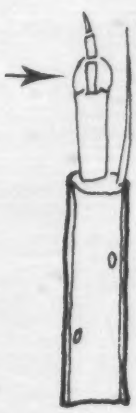
Thienemann (1954) reported the habitat of *E. brehmi* to be the stone fauna of Mittelgebirgsbäche. In Thienemann's classification these are middle mountain brooks with current speeds of up to 0.9 m/s and summer temperatures up to 17°C. Other species of *Eukiefferiella* which Thienemann found living on bare stones in these streams include *E. clypeata*, *E. cyanea*, *E. lobifera*, and *E. pseudomontana*.

## *Eukiefferiella brehmi* group

Body length of mature larvae 2.1–3.5 mm; middle abdominal setation prominent, seta/segment ratio 0.40–0.50.

Posterior parapods short, procerci only slightly longer than wide; anal tubules at least half as long as parapods; supraanal setae as long as parapods.

Head medium brown to dark brown; postoccipital margin with light area between two dark lines.



Antennal ratio 1.20–1.50; blade as long as segments 2–4; Lauterborn organs large.

Inner margin of mandible with 2–3 medium long serrations, reaching base of subdental seta; apical tooth longer than 1st lateral tooth.

Mentum with 5 pairs of lateral teeth; medians paired, rounded on outer edge, and fused for much of their length; ventromental plates barely discernible; mentum with angulate "shoulders."

## TAXONOMY

The name *E. gracei* was shown by Saether and Halvorsen (1981) to be a senior synonym of *E. potthasti*, as used by Lehmann (1972); *potthasti* had previously replaced *longicalcar*. Three European species are included in the *gracei* group: *gracei*, *fittkaui*, and *minor*. North American larvae that I have examined do not separate into distinct morphotypes and appear to be closest to *E. minor*.

Larvae of this group can be distinguished by the single wide median tooth of the mentum, a dark brown head, and pronounced abdominal setation. The group is most closely related to the *brehmi* and *similis* groups.

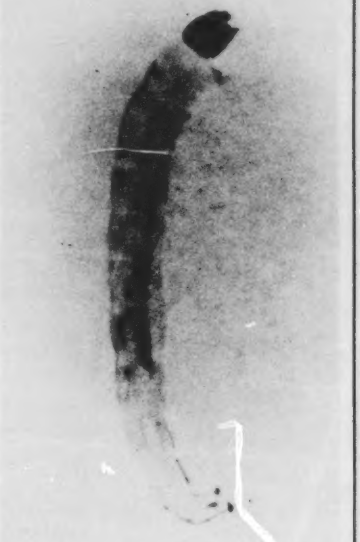
The problem persists of distinguishing some members of this group from *Cardiocladius*, a genus which is very close to *Eukiefferiella* phylogenetically. The problem has been addressed by Saether (1969, 1973) with the erection of the genus *Tokunagaia* (Saether, 1973, and a cladogenesis has been presented for the genera *Tvetenia*, *Dratnalia*, *Eukiefferiella*, *Tokunagaia*, and *Cardiocladius* (Saether and Halvorsen, 1981). However the proper placement of some larvae is still unresolved; we have associated larvae of *Cardiocladius* which have definite serrations on the inner margin of the mandible. The larva pictured for the *potthasti* group in Simpson and Bode (1980) is now of uncertain status; the one described in the present bulletin should be considered more representative of the group.

## ECOLOGY

The group is widely distributed and common in North America. I have examined larvae from Washington, Idaho, Colorado, Michigan, New York, and North Carolina. All are believed to have been collected from swift-flowing, cold streams. All my larval collections were from filamentous algae such as *Cladophora*. Elgmork and Saether (1970) reported larvae of the *longicalcar* type (*Eukiefferiella* sp. E and sp. F) and the *minor* type (*Eukiefferiella* sp. G and sp. H) from North Boulder Creek in the Colorado Rocky Mountains. The larvae of sp. G were the predominant chironomids in most of North Boulder Creek, at altitudes of 3,300–3,800 m and stream temperatures of 1–10°C.

Thienemann (1954) and Lehmann (1972) reported European species in the *gracei* group to be found in moss in strong currents, and several other studies reported similar findings. Pinder (1980) found *E. gracei* to be the dominant gravel species in May in an English chalk stream with high current velocities. Kownacka (1971) found *E. minor* to be the dominant macroinvertebrate species in the 1,000–1,500 m elevation range of a stream in the High Tatra Mountains. Larvae were collected from stones overgrown with moss and algae; the yearly temperature range was 4–7°C. Laville and Lavandier (1977) found *E. minor* in torrential streams in the Pyrenees Mts. at elevations 1,850–2,190 m; they found *E. fittkaui* at elevations of 1,950–2,370 m. The maximum temperature at 1,850 m was 13°C.

I have noted emergence periods in April for the species in New York and Washington.



Body length of mature larvae 3.5–4.0 mm; middle abdominal setation moderate, seta/segment ratio 0.35–0.50.

Posterior parapods short, only twice as long as wide; procerci not much longer than wide; supraanal seta as long as parapods.

Head dark brown; postoccipital margin black.

Antennal ratio 1.50–1.80; blade as long as segments 2–4; 3rd segment subequal to 4th segment.

Inner margin of mandible with 2–3 long serrations, reaching base of subdental seta; apical tooth longer than 1st lateral tooth.

Mentum with 5 pairs of lateral teeth; median tooth single, wide, and rounded or truncate; ventromental plates reduced, barely discernible; mentum with angulate "shoulders."

## TAXONOMY

This group is formed around species close to the single European species *E. cyanea*. When Thienemann (1936a) first collected the larva, he considered it unique enough to describe it as a new species on the basis of larvae and pupae alone, making an exception to his own rule never to describe without adults. The most distinguishing features of the larva are found in the posterior end, which has greatly elongated parapods, greatly reduced procerci, and only four small anal setae. Tilley (1979) described specimens taken in Alaska and has loaned me some of these. The larvae differ somewhat from the descriptions in Thienemann (1936a) and Zavřel (1939) in that the mentum of the North American species has the first lateral tooth mostly fused to the median tooth, while this is not mentioned for *E. cyanea*.

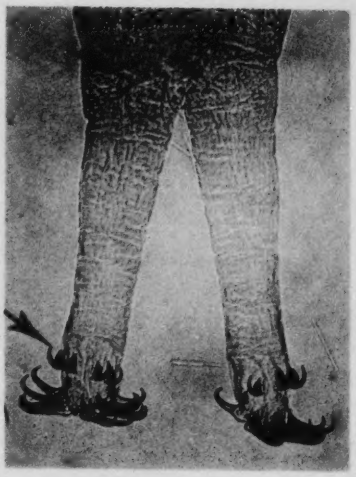
The larva and pupa of *E. cyanea* are keyed in Zavřel (1939). Lehmann (1972) also keyed the pupa but stated that the adult was still unknown.

## ECOLOGY

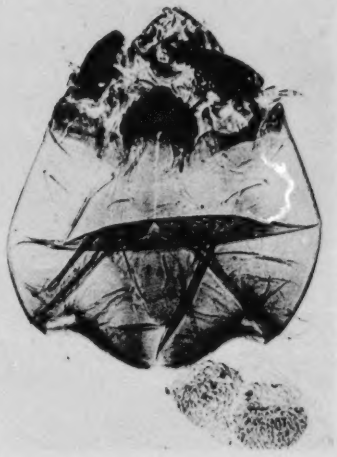
This group is rarely collected in North America. I have examined specimens collected by Larry Tilley in Alaska, and Coffman (1979) has reported a species occurring in Oregon. Tilley (1979) collected *cyanea* group larvae from the Dietrich and Atigun rivers, two Arctic-alpine streams in northern Alaska. This habitat is consistent with the habitat descriptions given by Thienemann (1954) for *E. cyanea*.

Thienemann (1954) discussed in detail the unique habitat of *E. cyanea* and how it is suited for such a habitat. He found the larvae living in a small mountain brook in Germany, below a waterfall fed by the highest snowfield (elevation 1,450 m). Later he also found this species in the Abisko region of Swedish Lappland. While most *Eukiefferiella* are algae or moss-dwellers, larvae of *E. cyanea* were found living on clean stones, free of growth. To be suited for such a rheobiontic life, the posterior parapods of the larva are greatly elongated, and the anal setae are greatly reduced. Thienemann noted that this is seen in many *Diamesa* and concluded that these are adaptations for attachment in strong currents.

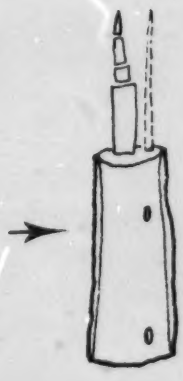
Body length of mature larvae 3.5–5.5 mm; middle abdominal setation greatly reduced.



Posterior parapods long, length/width ratio 4–6; procerci greatly reduced, hardly protruding, each bearing only 4 short anal setae; smaller claws of parapods placed more basally, separated from others.



Head short and rounded; medium brown to dark brown.



Antennal ratio 1.25–1.70; basal segment short and wide; blade about as long as segments 2–4.

No serrations could be discerned with certainty on inner margin of mandible, although Thienemann (1936a) reported long serrations for *E. cyanea*; 1st lateral tooth almost as long as apical tooth.

Mentum with 5 pairs of lateral teeth; median tooth single, truncate; 1st lateral teeth reduced and appressed to median tooth; ventromental plates large, pointed basally.

## TAXONOMY

The *pseudomontana* group as used here includes the European *E. pseudomontana* and its North American relative. Although the pupa of the North American species is similar to *E. pseudomontana*, the larva differs in several characters such as having two median teeth instead of one, having the 3rd antennal segment reduced or absent, and possessing an antennal blade only as long as segment 2. Until the adult is described, this species is placed provisionally in the *pseudomontana* group with the understanding that the group is used in a broader sense.

Goetghebuer (1935) first described the adult of *E. pseudomontana*, and Thienemann (1936a) the larva and pupa, from lower mountain brooks in Germany. Thienemann placed it with *E. lobifera* as a subgroup in the *brevicalcar* group. Zavřel (1939) also keyed the larva and pupa, placing the species with *lobifera* in the *lobifera* group. Gowin's (1943) description of *E. ruttneri* from the Austrian Alps was later synonymized (Lehmann, 1972) with *E. pseudomontana*. Lehmann (1972) keyed the pupa and adult male of *E. pseudomontana* and placed the species closest to the *claripennis* group.

The larva of the North American species in this group can be recognized by the wide, rounded median teeth of the mentum, the prominent postoccipital margin, and the enlarged ventromental plates. It resembles some species in the *brevicalcar* group but can be distinguished from these by the ventromental plates and the smaller ventral seta of the 10th abdominal segment.

## ECOLOGY

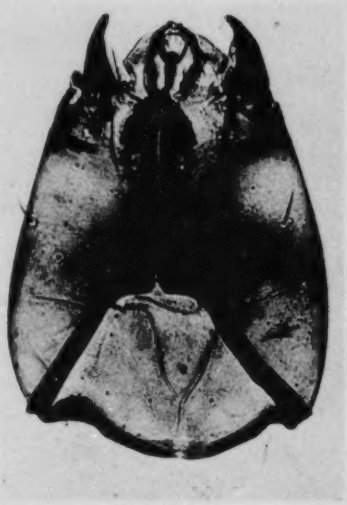
I have examined specimens from Montana, New York, and North Carolina. In New York it is quite common in rivers and their tributaries in the Catskill Mountain region, being found in such streams as Schoharie Creek, Kaaterskill Creek, Neversink River, and the Delaware River. In these streams it was sometimes found to be numerous below mild sewage outfalls, although in these instances minimum dissolved oxygen concentrations of 6.0 ppm were maintained. This species displays a habitat preference for bare or silted stones, often living in the thin slime layer of algae on top of submerged stones. The larvae build a rectangular, gelatinous case, which usually has small amounts of silt and detritus attached. Because of its preference for these types of surfaces, this species sometimes appears on multiple-plate samplers.

The habitat preference for bare stones has been reported for *E. pseudomontana* by Gowin (1943) and Thienemann (1954). Thienemann (1954) listed it from the Mittelgebirgsbäche, the same habitat as *E. brehmi*. To date the only records for *E. pseudomontana* are from Germany and the Austrian Alps (Lehmann, 1972).

My collection records for the North American species indicate it to be bivoltine, with emergences in July and September.

Body length of mature larvae 2.5–3.3 mm; middle abdominal setation reduced.

Posterior parapods 3 times as long as wide; procerci not longer than wide; anal tubules more than ½ as long as parapods; supraanal setae reduced.



Head light brown to dark brown; postoccipital margin wide, dark, and prominent.

Antenna with 3rd segment reduced or absent; antennal ratio 1.40–1.80; antennal blade only as long as 2nd segment.

Inner margin of mandible with 2–3 short serrations not reaching base of subdental seta; apical tooth longer than 1st lateral tooth.

Mentum with 5 pairs of lateral teeth; median teeth paired, rounded, and twice as wide as laterals; ventromental plates large, triangular; mentum striated.

## TAXONOMY

The *claripennis* group of Zavřel (1939) and Lehmann (1972) here is separated into the *brevicalcar* and *claripennis* groups, based on larval and pupal characters. The *claripennis* group will include larvae with very narrow teeth on the mentum and pupae with thoracic horns having a tip no longer than the base. The *brevicalcar* group at present is the largest in the genus, yet the larvae are not frequently encountered, probably because many species emerge very early in the spring.

Larvae in the group exhibit much variation. Some larvae possess a mentum with very wide, rounded median teeth, resembling *pseudomontana* group larvae. Another larva has a mentum with a single peaked median tooth, similar to the *Tvetenia discoloripes* group. Other species have paired median teeth and are difficult to distinguish as larvae from the *claripennis* group.

The European species placed in the *brevicalcar* group are *E. brevicalcar*, *E. fuldensis*, *E. lobifera*, and *E. tirolensis*. The larvae of *E. brevicalcar* and *E. lobifera* are keyed in Zavřel (1939). The larvae of *E. fuldensis* and *E. tirolensis* are apparently undescribed.

## ECOLOGY

The diversity of species included in this group is reflected in the range of habitats they occupy. All specimens collected in New York were found among blue-green algae in cool, swift-flowing brooks. However, other species have been found in large warm rivers such as the Susquehanna River in Pennsylvania and the Ohio River in Ohio. I have also examined specimens from small, higher-elevation streams in North Carolina and South Carolina, from the Colorado Rocky Mountains, and from a small stream in Minnesota.

Species in the *brevicalcar* group have also been reported from a wide variety of habitats in the European literature. Thienemann (1954) listed *E. brevicalcar* in the moss fauna of high mountain brooks, transition brooks, and upland brooks. Cure (1972) found *E. brevicalcar* in a tributary of the Danube River. Laville and Lavandier (1977) reported *E. tirolensis* living in moss at the 1,850–2,190 m elevation of a torrential stream in the Pyrenees. The maximum summer temperatures of the stream were 7–15°C, and they concluded this was a cold stenothermal species. Dratnal (1970) reported *E. brevicalcar* from stones, moss, and bottom sediment in Polish streams.

Lehmann (1971) believed *E. brevicalcar* to have a spring and fall generation, and Coffman (1973) listed the emergence period of a species in the *brevicalcar* group as extending from May to November. My observations for this group indicate very early spring emergences for some species, with some species possibly being univoltine. David Beckett (pers. comm.) has an extensive collection of data for a species from the Ohio River showing it to be univoltine. Larvae were very numerous in the winter months only, emerging in April or May.

*Eukiefferiella brevicalcar* group

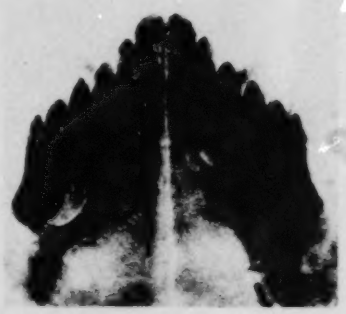
Body length of mature larvae 3.0–5.0 mm; body usually blue-green mottled with violet; middle abdominal setation greatly reduced.

Posterior parapods medium long, 3–4 times as long as wide, shorter than anal setae; procerci no longer than wide; prominent ventral setae.

Head light brown to dark brown; postoccipital margin dark.

Antenna with 3rd segment reduced or absent; antennal ratio 1.60–2.35; antennal blade only as long as 2nd segment.

Inner margin of mandible with 3 small serrations, not reaching base of subdental seta; apical tooth usually not much longer than 1st lateral tooth.



Mentum with 5 pairs of lateral teeth; median either single and peaked or paired and wider than 1st laterals; ventromental plates long, pointed at bottom.

## TAXONOMY

The *claripennis* group as used here denotes the species *E. claripennis* and those species with larvae very similar to the *claripennis* morphotype, excluding those more similar to *E. brevicalcar*. Pupae possess thoracic horns with the tip no longer than the base; larvae have a mentum with very narrow paired median teeth and antennae with only four segments. These group limits may result in restricting the group to the single species *claripennis*, but this will have to be resolved by adult taxonomy. The wide ecological tolerances attributed to this species/species-group are sufficient grounds for attempting to separate it from the *brevicalcar* group.

The lectotype of *E. claripennis* was redescribed by Oliver (1970), who suggested that *E. hospita* may be a synonym. The North American species *E. brevinervis* (Malloch, 1915) was redescribed by Sublette (1970); this may also be a synonym of *claripennis*. The larva and pupa of *E. brevinervis* were keyed and figured by Roback (1957).

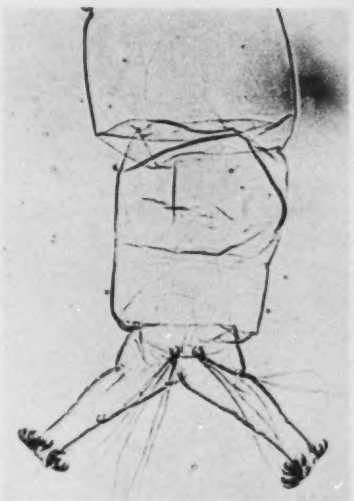
## ECOLOGY

The *claripennis* group is widespread and common in North America, and is the most tolerant *Eukiefferiella*. It inhabits larger, warmer rivers as well as high-altitude cold-water streams. It has been reported from the Northwest Territories (Madder et al., 1977; Oliver et al., 1978), Pennsylvania (Roback, 1957; Coffman, 1971), and New York (Simpson and Bode, 1980). I have also examined specimens from Idaho, Washington, Minnesota, Colorado, Michigan, Manitoba, North Carolina, and South Carolina. In New York I have collected it from large, lowland streams such as the Hudson, Mohawk, Black, and Delaware rivers. It is apparently tolerant of sewage wastes if minimum dissolved oxygen concentrations of 5.0 ppm are maintained, and it thrives in acid brooks (pH 4.5–4.7). It was also numerous below a reservoir where hypolimnion releases caused great fluctuations in flow and temperature.

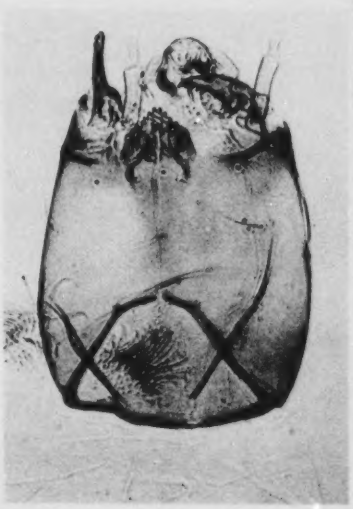
In Europe *E. claripennis* has been reported from a wide variety of environmental conditions and microhabitats. Some of these habitats include macrophytes, gravel, and soft sediment in an English chalk stream (Pinder, 1980); moss of lower mountain brooks in Germany (Thienemann, 1954); littoral zones of lakes (Brundin, 1949); and even bays, canals, and a water treatment plant (Zavřel, 1939). Zavřel (1939) also found it in a river polluted with wastewater from a leather and glue factory and in a canal that was green with algae.

Madder et al. (1977) found *E. claripennis* overwintering in cocoons as second-instar larvae in the Harris River, Northwest Territories. Coffman (1971) reported *E. brevinervis* ingesting about 98% algae and 2% detritus.

Body length of mature larvae 2.1–3.5 mm; body green-brown to blue-violet; middle abdominal setation greatly reduced.



Posterior parapods medium long, shorter than anal setae; procerci no longer than wide.



Head light brown to dark brown; postoccipital margin dark and moderately wide.

Antenna with only 4 segments; antennal ratio 1.80–2.15; antennal blade only as long as 2nd segment.

Inner margin of mandible with 3 small serrations, not reaching base of subdental seta; apical tooth about as long as 1st lateral tooth.

Mentum with 5 pairs of lateral teeth; medians paired, sometimes pointed, no wider than 1st lateral teeth; ventromental plates short, triangular; mentum with longitudinal grooves of less sclerotized streaks.

## TAXONOMY

Larvae in this group are poorly known, so we cannot be very precise about group limits. The most important group characters seem to be the location (midpoint) of the antennal sense pit, the rounding of the ventromental plates at the posterolateral corner, and the shape of the median teeth of the mentum which are well separated and often nearly quadrate. Oliver et al. (1978) provided a good photograph of the characteristic mentum type under *Eukiefferiella* sp. 4.

The three known European species belonging to this group are *E. excellens*, *E. rectangularis*, and *E. scutellata*. Brundin (1956) keyed the adults of these species, and Lehmann (1972) keyed the pupae and adults. Lehmann listed the larvae for all three species as unknown. Saether (1968) has described *E. oestbyei* from Norway, but Lehmann (1972) synonymized this with *E. rectangularis*.

Before *E. rectangularis* was formally named and described in the adult stage, Thienemann (1944) gave a description of the pupa as "*Akiefferiella* Type *Abisko*." He placed it near *Akiefferiella coerulescens* because the pupa lacked thoracic horns and named it after the Abisko region in Swedish Lappland where he found it.

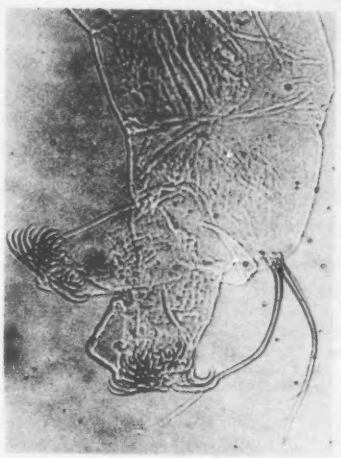
## ECOLOGY

Although Coffman (1979) reported pupae of this type only from Western states, I have just recently collected some larvae in New York which appear to belong to the *rectangularis* group. All other records are from western North America and show the group to have a preference for northern latitudes or higher altitudes. Oliver's specimens are from Greenland, Northwest Territories, and Yukon Territory. Tilley (1979) reported a larva (*Eukiefferiella* sp. 1) from Alaska which belongs to the *rectangularis* group. Stanley Dodson has loaned me specimens collected in the Colorado Rocky Mountains, and Elgmork and Saether (1970) have recorded collections of larvae here (as *Eukiefferiella* sp. J). Elgmork and Saether (1970) found larvae in high mountain brooks, elevation 3,400–3,600 m, where the temperature range was 2–5°C.

Little has been reported on the microhabitat of this group. Because the larvae have quite stout posterior parapods, they probably inhabit moss or filamentous algae.

*Eukiefferiella rectangularis* group

Body length of mature larvae about 2.5–3.9 mm; body color not known; middle abdominal segments with setae less than .10 length of corresponding segment.

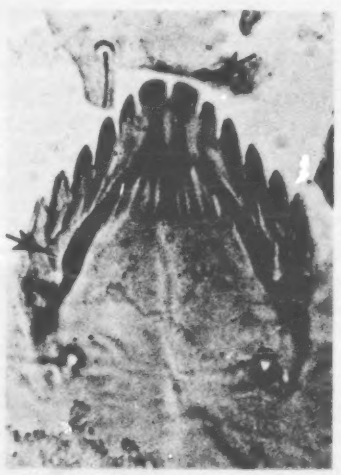


Posterior parapods short, only about twice as long as wide; procerci about as long as wide.

Head medium brown to dark brown; postoccip.tal margin dark and moderately wide.

Antenna with 5 segments; AR 1.30–1.95; antennal sense pit located at midpoint of basal segment; blade longer than segment 2.

Inner margin of mandible with 2 serrations, moderately long but not reaching base of subdental seta; 1st lateral tooth large, subequal to apical tooth.



Mentum with 5 pairs of lateral teeth; medians paired, well separated, and squarish or rounded; ventromental plates rounded at postero-lateral corner.

## TAXONOMY

The single European species on which this group is based, *E. coerulescens*, has been the subject of much taxonomic confusion. Thienemann (1936b), apparently working with a pupa with some setae missing, erected a new genus, *Akiefferiella*, for the species *coerulescens* (Kieffer). Johannsen (1937) retained *Akiefferiella* as a group in *Spaniotoma (Eukiefferiella)*; he listed *coerulescens* as a sister species to the Nearctic *Spaniotoma sordens* (now a *nomen dubium*), erroneously stating that *coerulescens* lacked mandibular serrations. Roback (1957) similarly treated *E. coerulescens* and *E. sordens* and stated that *coerulescens* had long body hairs. This conflicts with Zavřel (1939), who has given the most complete description of the larva of *coerulescens*. Beck's (1976) key included the larva of "*Eukiefferiella cerulescens* gp.," but this almost certainly refers to *Tvetenia bavarica* group.

The *coerulescens* group is closely related to the *rectangularis* group, both having the midpoint location for the larval antennal sense pit. The mentum of the *coerulescens* group larva resembles that of the *claripennis* group, except that the 1st pair of lateral teeth are mostly fused with the medians. The ventromental plates are less well developed than in the *claripennis*-group. Zavřel's (1939) drawing of the mentum of *E. coerulescens* shows pointed median teeth.

There appears to be at least three North American species belonging to the *coerulescens* group.

## ECOLOGY

The group is apparently widespread in North America, but in my experience is not commonly collected. I have collected pupae from three trout streams in New York, and have examined additional specimens from the Colorado Rocky Mountains and from Alberta and Manitoba. From these brief records we can state only that the group seems to prefer small to medium-sized streams that are mostly free from pollution.

The Palearctic distribution of *E. coerulescens* includes Europe, North Africa (Lehmann, 1972), and Norway (Brundin, 1956). Thienemann (1954) listed it from the moss fauna of transition brooks and upland brooks. Lehmann (1971) collected larvae from the stones and moss in strong current sections of the Fulda. Lehmann (1971) also stated that it is known from the littoral zones of lakes, living in the crust formation of blue algae and in filamentous green algae on stones just beneath the water surface. Laville and Lavandier (1977) reported *E. coerulescens* from a torrential stream (elevation 1,950–2,150 m) in the Pyrenees.

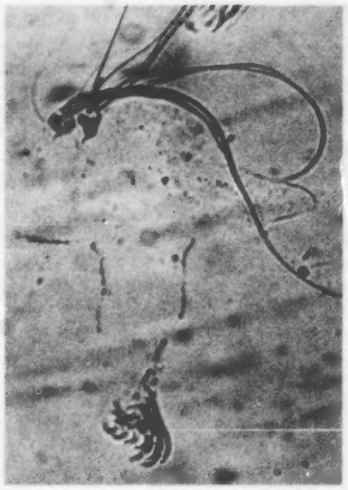
Lehmann (1971) has stated that *E. coerulescens* has strong spring and autumn emergences, with few adults emerging in the summer months.

no

photograph

available

Body length of mature larvae probably about 3 mm; body color not known; middle abdominal segments with setae less than .10X length of corresponding segment.



Posterior parapods apparently as long as anal setae; procerci well-sclerotized, about as long as wide.

Head medium brown, postocciput margin dark brown.

Antenna with 4 segments; AR 1.65–1.75; sense pit located at midpoint of basal segment; blade about as long as segment 2.

Mandible with apical tooth longer than 1st lateral; inner margin with 2–3 small serrations, sometimes barely discernible.

Mentum with 5 pairs of lateral teeth, 1st pair elongate and partially fused to medians; medians mostly fused, width subequal to 1st laterals; area of ventromental plates darkened, plates barely discernible.

## PHYLOGENETIC RELATIONSHIPS

The cladogram (Fig. 3) illustrates possible phylogenetic relationships within the genera, based on larval morphological characters. Methods were similar to those of Hennig (1950) as described in Mayr (1969) and adapted to the Chironomidae by Lehmann (1972) and Saether (1975, 1977b). The trends listed below are indicated as either plesiomorphic, i.e., primitive (p) or apomorphic, i.e., derived (a). In the cladogram, single line connections between rectangles indicate symplesiomorphies, i.e., shared primitive characters, while crosshatched connections indicate synapomorphies, i.e., shared derived characters.

**Trends:**

1. Abdominal setation strong, some setae at least half as long as width of segment on which they occur (a); abdominal setation moderate to reduced, setae less than half as long as width of segment on which they occur (p).
2. Procerci short, less than 1.5 times as long as wide (a); procerci long, at least 1.5 times as long as wide (p).
3. Labral seta I simple (a); labral seta I divided (p).
4. Serrations on inner margin of mandible short, not reaching base of subdental seta (a); serrations on inner margin of mandible long, reaching base of subdental seta (p).
5. Mentum with single median tooth (a); mentum with paired median teeth (p).
6. Abdominal setation moderate, some setae at least .10 as long as width of segment on which they occur (a); abdominal setation reduced, setae less than .10 as long as width of segment on which they occur (p).
7. Antennal blade about as long as segment 2 (a); antennal blade as long as segments 2–4 (p).
8. Mentum with four pairs of lateral teeth (a); mentum with five pairs of lateral teeth (p).
9. Labral seta III bifid (a); labral seta III simple (p).
10. Antennal ratio less than 1.20 (a); antennal ratio greater than 1.20 (p).
11. 3rd antennal segment greatly reduced (a); 3rd antennal segment about equal to 4th (p).
12. Procerci and anal setae greatly reduced (a); procerci and anal setae not greatly reduced (p).
13. Antennal ratio greater than 1.50 (a); antennal ratio less than 1.50 (p).
14. Mentum with single median tooth (a); mentum with paired median teeth (p).
15. Antennal sense pits proximal (a); antennal sense pits distal (p).
16. Procerci greatly reduced (a); procerci normal (p).
17. Anal setae greatly reduced (a); anal setae normal (p).
18. Ventral seta (of posterior parapods) reduced (a); ventral seta normal (p).
19. Mentum with narrow median teeth (a); mentum with wider medians (p).
20. Antenna 4-segmented (a); antenna 5-segmented (p).

The scheme presented is consistent with evolutionary trends observed in other genera of the Orthocladiinae. Larval characters (Trends 1–3) clearly give some justification for splitting off the *discoloripes* and *bavarica* groups, as Saether and Halvorsen (1981) have done by placing these in *Tvetenia*. The present scheme differs from Lehmann's (1972) pupal and adult cladogram in that the *devonica* group has been given a more plesiomorphous placement. In the present diagram larvae of the *devonica* group are seen to share some major characters with the *gracei*, *similis*, and *brehmi* groups. These characters include moderate body setation, low antennal ratios, long mandibular serrations, and a long antennal blade. Zavřel (1939), who had not yet associated a larva of the *devonica* group, was impressed enough with the similarities to call the larva "cfr. *similis* juv. 1." Lehmann (1972), however, suggested that the *devonica* group is more distant from these groups because the pupae lack recurved hooks on sternites VI-VII, and on this he based their phylogenetic placement. However, although *E. ilkleyensis* has no recurved hooks on the sternites, *E. devonica* bears a row on sternite VII. Thus it seems possible that the *devonica* group may have had an ancestor with recurved hooks on sternites VI-VII. On this basis it would be consistent to place the *devonica* group near the *gracei*, *similis*, and *brehmi* groups, which bear recurved hooks on pupal sternites VI-VII.

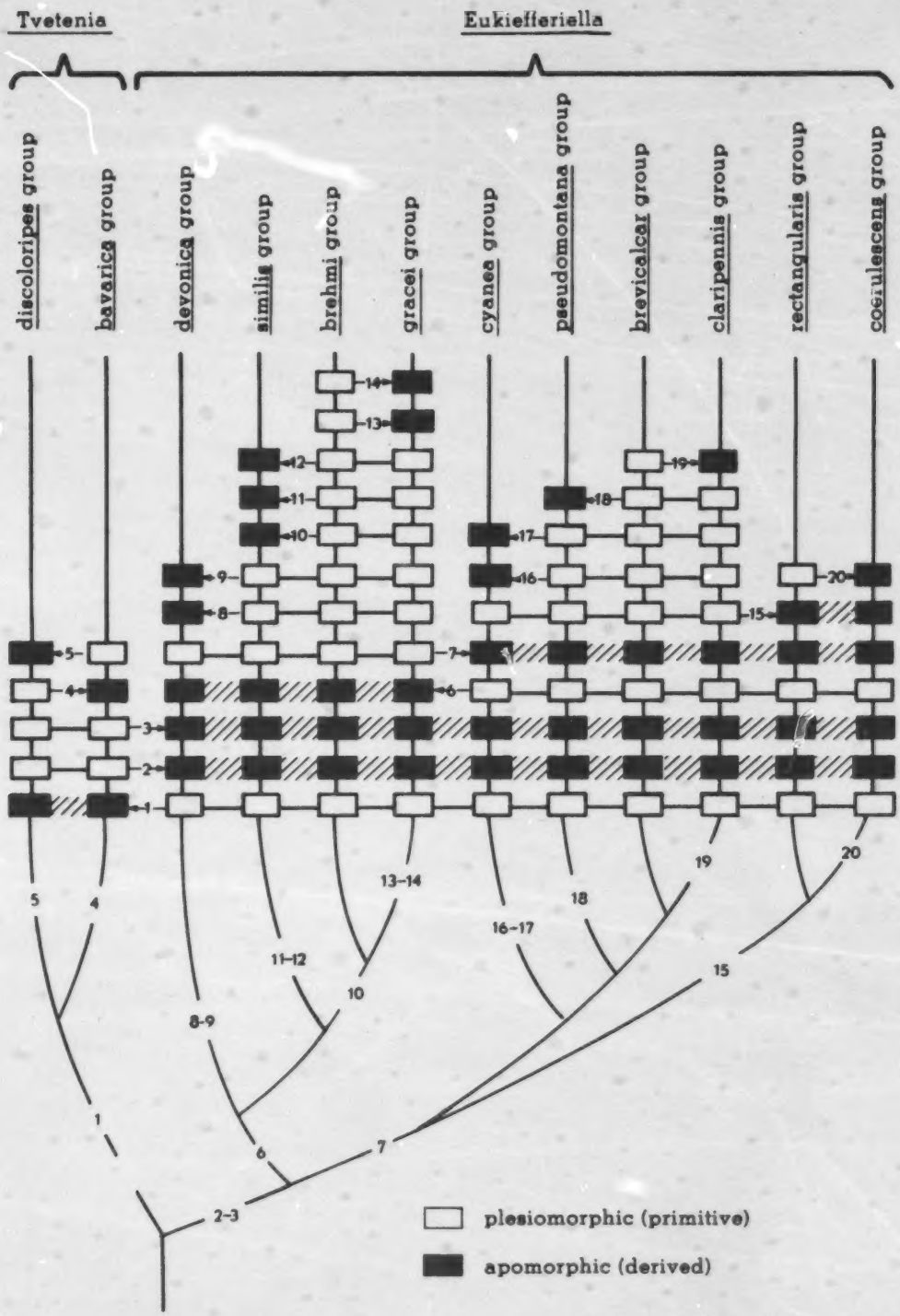



Figure 3. Possible phylogeny of the species groups of Eukiefferiella and Tvetenia, based on larval trends.

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